

Of course, it can be appreciated that a variety of other types of magnetometers and gyroscopes may be implemented in accordance with alternative embodiments.

The embodiments and examples set forth herein are presented to best explain the present invention and its practical application and to thereby enable those skilled in the art to make and utilize the invention. Those skilled in the art, however, will recognize that the foregoing description and examples have been presented for the purpose of illustration and example only. Other variations and modifications of the present invention will be apparent to those of skill in the art, and it is the intent of the appended claims that such variations and modifications be covered.

The description as set forth is not intended to be exhaustive or to limit the scope of the invention. Many modifications and variations are possible in light of the above teaching without departing from the scope of the following claims. It is contemplated that the use of the present invention can involve components having different characteristics. It is intended that the scope of the present invention be defined by the claims appended hereto, giving full cognizance to equivalents in all respects.

The embodiments of the invention in which an exclusive property or right is claimed are defined as follows.

Having thus described the invention what is claimed is:

1. An apparatus for sensing magnetic fields, wherein the apparatus comprises:

- a cell adapted for containing alkali atoms at their vapor pressure so that said alkali atoms can become polarized wherein said cell comprises at least one of a plurality of angled walls to allow counter-propagating probe beams;
- a light source generating a light field containing more than one propagation vector, wherein said light source is arranged to pass said light field through said cell;
- a light source adapted to circularly polarize light;
- at least one photo detector adapted to measure a magnetic field strength based on a reaction of said light field with said alkali atoms after said light field is passed through said cell.

2. An apparatus according to claim 1, at least one coil arranged near said cell adapted to do at least one of create a precise static magnetic field and compensate for residual magnetic fields.

3. An apparatus according to claim 2, wherein said at least one coil comprises at least one of a three-axis coil and a radio-frequency ("RF") coil.

4. An apparatus according to claim 2, wherein said coils are highly conductive traces on a substrate.

5. An apparatus according to claim 1, further comprising a spacer and a magnetic shield, said spacer comprising a non-magnetic material.

6. An apparatus according to claim 1, including a flex circuit adapted to provide signals from the at least one photodetector to a computer adapted as external signal conditioning and detection circuitry facilities.

7. An apparatus according to claim 6, wherein said flex circuit comprises a photo definable polyimide.

8. An apparatus according to claim 6, wherein said alkali vapor cell comprises:

- a plurality of alkali atoms;
- a buffer which prevents collisions of said alkali atoms with walls of said cell.

9. An apparatus according to claim 8, wherein said buffer gas comprises N₂ or Ne.

10. An apparatus according to claim 1, wherein said cell is etched in a silicon material and bonded between two layers for interconnects.

11. An apparatus according to claim 1, wherein at least one of a plurality of highly reflective mirrors is deposited on said cell walls to increase the strength of a signal received from said photodiodes.

12. An apparatus according to claim 1, wherein said light source is at least one of a laser, semiconductor laser and a vertical-cavity surface-emitting laser ("VCSEL").

13. An apparatus according to claim 1, wherein said light source further comprises a waveplate adapted to circularly polarize said light, and wherein said light source includes an additional optical feature to attenuate the light and change its spatial mode.

14. An apparatus to claim 1, wherein said photodetector comprises photodiodes positioned on a base plate.

15. An apparatus according to claim 1, wherein said apparatus operates as a micro-electro-mechanical system ("MEMS") device.

16. An apparatus according to claim 1, further comprising a heater, wherein said heater is used to heat said cell and a thermal sensor is used to stabilize the temperature at a predetermined value.

17. An apparatus according to claim 16, wherein at least one of said heater and said thermal sensor is implemented as traces on said base plate.

18. An apparatus according to claim 1, wherein a spacer is used to align and attach said cell to said base plate.

19. A magnetic field sensing device, comprising:

- a magnetic shield to suppress external magnetic fields;
 - a cell adapted for containing alkali atoms at a vapor pressure so that said alkali atoms can become polarized;
 - a light source generating light field comprised of more than one propagation vector, wherein said light source is arranged to pass said light field through said cell;
 - a light source adapted to circularly polarize light;
 - at least one photodetector adapted to measure a magnetic field strength based on a reaction of said light with said alkali atoms after said light field is passed through said cell, wherein said at least one photodetector comprises photodiodes positioned on a base plate; and
- wherein said apparatus is adapted in a gyroscope implementation that comprises an additional "noble" gas.

20. An apparatus according to claim 19, wherein:

- at least one coil is arranged near said cell and is adapted to create a static magnetic fields;
- at least one coil is adapted to drive a precession of the noble gas atoms about the static magnetic field; and
- at least one is coil adapted to drive a precession of the alkali atoms about the quasi-static magnetic field created by the static field and the field due to the noble gas atoms.

21. An apparatus according to claim 19, wherein:

- at least one coil adapted to create a static magnetic field that largely cancels the field of the noble gas seen by the alkali atoms;
- the static polarization change of the alkali atoms due to the interaction of the alkali atoms with the noble is under conditions or rotation is monitored; and
- wherein said apparatus is adapted in a comagnetometer implementation.

22. An apparatus according to claim 19, wherein said cell comprise at least one of a nuclear magnetic resonance ("NMR") cell and an alkali vapor cell.

23. An apparatus according to claim 19, wherein:

- said cell comprises at least one of a plurality of angled walls to allow counter-propagation probe beams;
- said cell comprises at least one of a nuclear magnetic resonance ("NMR") cell and an alkali vapor cell;